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# The Residential Real-Estate Industry in India: Investigating Evidence for an Asset Bubble

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# THE RESIDENTIAL REAL-ESTATE INDUSTRY IN INDIA: INVESTIGATING EVIDENCE FOR AN ASSET BUBBLE

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## Abstract

The objective of this thesis is to examine the differences in residential property prices across different cities in India. Soaring prices have led to increasingly unaffordable property prices in large metropolitan cities. As a result, there has been academic discourse about the existence of a housing bubble in recent years. In the past, empirical research has focused on national level trends due to a lack of city-level data. I investigate the city-fixed effects on growth in house prices across fifteen different cities. Although different empirical models suggest different conclusions about these effects, point estimates suggest above-normal growth in house prices in Delhi for the period 2009-2013.

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## I. Introduction

The real-estate industry is inextricably linked to socio-economic growth and development. Increasing the availability and affordability of housing can improve the quality of life for citizens, and the overall development of infrastructure improves productivity within the economy. House prices also indirectly impact macroeconomic health through the wealth effect: as house prices rise, home-owners feel wealthier and are likely to increase consumption and boost aggregate demand (Calomiris, Longhofer, & William, 2012).

The residential real-estate industry in India is complex and dynamic. Varying economic and demographic characteristics across the country result in differences in the housing markets in different cities. While soaring prices have led to speculation about a housing bubble in large cities like Mumbai and Delhi, prices in tier-II and tier-III cities such as Kochi and Hyderabad have remained relatively stagnant (NHB, 2013). Demand for housing has increased in recent years due to rising per capita incomes, the increasing penetration of housing finance, and increasing population density in urban areas. The growing middle class, expected to grow from 224 million to 583 million by 2025, has added to existing pressure on the demand for housing (Mustafi, 2013).

The Indian government is faced with several challenges as it attempts to stabilize the housing market and increase accessibility to affordable housing. In light of rising inflation and twin current account and fiscal deficits, the government has attempted to increase liquidity and encourage household saving during 2012-13 by pursuing tight monetary policy (Moneycontrol, 2013). Consequently, investment growth in the industrial sector experienced a slowdown and contributed - along with a slowdown in the

industrial, agriculture and services sector- to a decline in GDP growth to 5 percent in 2012-13 (Moneycontrol, 2013) . Residential real-estate markets have followed suit, with Mumbai and Delhi experiencing a 0.5 percent and 1.5 percent fall in prices respectively, and cities like Chennai and Kolkata dropping by 2.3 percent and 4.1 percent respectively (Kumar, 2013).

The objective of this paper is to examine how the macroeconomic environment and monetary policy impact trends in house prices in different cities. I will test the hypothesis that house prices in certain metropolitan cities such as Delhi and Mumbai have seen above-normal growth rates in recent years. My hypothesis is motivated by literature speculating about existence of a housing bubble in these cities (Anand, 2010).

In order to test my hypothesis I construct a panel of fifteen cities for fifteen quarters since 2009. I use a fixed effects model to account for omitted variables that cannot be measured and attempt to determine whether large metropolitan cities display positive fixed effects in house price growth. I then investigate whether the slowdown of the Indian economy since 2010-11 has impacted the growth of house prices (Schaffer, 2013).

In the past, literature pertaining to residential real-estate markets in India has focused on national level house prices as well as analysis of certain cities such as Mumbai (Gandhi, 2000). However, the vast majority of this literature is outdated. Since 2007, the National Housing Bank has published a house price index (HPI) called the Residex for fifteen cities in India and my objective is to use this to demonstrate city-wise variation in house markets while controlling for economy-wide interest rates.

My results suggest that the real interest rate is statistically significant, and negatively related to change in house prices as basic economic theory would suggest (Mankiw, 2011). Although point estimates suggest that four out of the six metropolitan cities (including Delhi and Mumbai) display above-normal increases in house prices, different ways of computing the standard errors suggest different conclusions about the significance of these results.

There are two major qualifications for the empirical analysis I present in this thesis. Firstly, that I use 2007 as a base year. By this time, prices in metropolitan cities had already surpassed those in other cities. Prior to 2009, both Delhi and Mumbai had experienced periods of rapid growth in house prices[1]. As a result, the available data does not capture the full extent of above-normal house price growth rate experienced in these cities. Secondly, urbanization and demographic trends that contribute to the pressure on housing markets could not be accounted for in this dataset due to the fact that census data is reported in five year intervals and because economic data used to construct my independent variables is unavailable at the city-level.

[1] Figure 3

## II. Literature Review

The literature pertaining to the real-estate market in India consists primarily of reports published by the Reserve Bank of India and by the National Housing Bank. The Report on Trend and Progress of Housing in India (2012) describes the dynamics of the housing market in India. The National Housing Bank was established by the Reserve Bank of India in 1988 in order to promote private real estate acquisition. The NHB is also responsible for regulating and refinancing social housing programs. In its yearly reports, the organization summarizes the issues concerning housing in India. The primary focus is the availability of affordable housing and some of the impediments include overpopulation of certain areas, the lack of affordable finance, infrastructure and regulatory hurdles. Urbanization has led to demographic changes across the country. According to census data, the percentage of population living in urban areas rose from 28 to 31 percent between 2006 and 2011, and is estimated to have risen further in recent years (NHB, 2012).

Publications by the Reserve Bank of India focus on the deployment of housing finance in India. Mohanty (2013) discusses the future of housing finance in light of the demand-supply gap, favorable demographics and increasing urbanization. He asserts the need to preserve financial stability along with attempts to increase the availability of housing finance and presents evidence from Reinhard and Rogoff (2009) to illustrate that the six major banking crises in advanced economies since the mid-1970s were associated with a housing bust. Mohanty compares the housing market in India with the housing market in the US, observing several crucial differences such as “the predominance of new construction and first time ownership” in India. Yet, he suggests it is important to apply

lessons learned from the sub-prime crisis in order to prevent a financial crisis due to a housing bust.

Gandhi (2012) describes the pressure on house prices in Mumbai over recent years. As the city became a center for economic and commercial activities, Mumbai experienced a rapid growth in population leading to distortions in the housing markets in India that impede the availability of affordable housing. The paper illustrates a mismatch between household income and house prices evidenced by the fact that "at the present income distribution and institutional rates, only 5-6 percent of households can afford a house in Mumbai" (Gandhi, 2012). It also illustrates a violation of the household's stock and flow principle that is essential for equilibration in the housing sector (Lipsey & Harbury, 2004). When measured against the distance from a city's central business district, most cities in the world have a downward sloping Floor Space Index (FSI) (Bertraud, 2010). However, property prices in Mumbai violate the principle that there is a flat FSI line against distance from the city center. In these big cities, house developers cater to a small proportion of the population – the rich elite – by focusing on the construction of luxury housing (Gandhi, 2012). Although Gandhi focuses on Mumbai in his paper, he suggests that most Indian cities face "issues of infrastructure, slum proliferation and inefficient urban land management" in the housing sector.

Several pieces of economic literature describe the relationship between residential real-estate and the macroeconomy. Goodheart & Hoffman (2007) examine the effects of house prices on the macroeconomic environment to demonstrate how a contraction in house prices can have "a severe contractionary effect on output" and that house prices reflect changes is beliefs and economic speculation. DiPasquale & Wheaton (1996)

distinguish between a micro and a macro approach to real estate markets. The micro approach emphasizes the importance of structural and geographic factors in determining house prices. Wheaton suggests that structural characteristics such as the level of development affect the willingness to pay across different locations. The macro approach deals with the effect of high level forces such as growth, industry and competitiveness on real-estate markets in different cities.

Case and Shiller (2004) discuss the role of expectations in causing a bubble in the housing market, identifying this as a situation in which "excessive public expectations of future price increases cause prices to be temporarily elevated." The rapid growth in house prices that have been seen across several cities in India is considered to be the first sign of a bubble. Yet, this is not conclusive evidence for the existence of a bubble. The extent to which changes in macroeconomic fundamentals, including incomes and interest rates, explain these growth rates can give us insight into whether it is appropriate to speculate a bubble.

Joshi (2006) examines preliminary evidence to suggest the existence of an asset bubble in the Indian housing market. He used a structural VAR model proposed by Blanchard and Quah (1989) to study the shocks to house prices that can be attributed to the monetary variables and income growth. The paper concludes that the Indian housing market was well equilibrated and that the risk of a bubble was not significant at this time. Another important finding was that monetary policy, specifically the interest rate, was the single most important determinant of the future growth of the housing market.

## III. Macroeconomic Overview

India, the world's fourth-largest economy with a population of 1.2 billion, is still in crucial stages of economic development. Over the past decade, the country has seen tremendous growth and change. According to the *Macro-economic Framework Statement* issued by the Ministry of Finance, The decadal average growth rate 2003-04 to 2012-13 was reported at 7.9 percent, with several consecutive years of 9 percent growth rates before the financial crisis of 2008. Since 2011-12 the Reserve Bank of India (RBI) has been using tight monetary policy to deal with uncertainty in the global economy. As a result, industrial growth has slowed in recent years and gross domestic product at factor cost was reported at 5 percent for 2012-13 (Ministry of Finance, 2013). Simultaneously, inflation has been accelerating with Wholesale Price Inflation (WPI) rising to 6.46 percent in September, 2013 and inflation rising to 9.84 percent (Kala, 2013). The Indian economy has been running twin deficits with a fiscal deficit of US$147 billion and a current account deficit at 4.6 percent of GDP (Ministry of Finance, 2013). The adoption of tight monetary policy has resulted in a decline in quarterly growth rate of GDP and declining government revenues from the industrial sector. Furthermore, negative export growth rates have led to unfavorable balance of payments. Simultaneously, the Indian Rupee has been on a downward trend since August 2011 and hit an all-time low of INR 68.80 against the US Dollar in August 2013 (Ministry of Finance, 2013).

The real-estate industry plays a crucial role within the dynamic landscape of the Indian economy. In 2013, it is estimated that the real-estate market contributed to 6.3 percent of GDP (IBEF, 2013). This sector is projected to generate 7.6 million jobs in this period, and over 17 million by 2025 (IBEF, 2013). In India, housing ranks fourth in terms

of the multiplier effect on the economy and third in terms of its linkages to ancillary industries (NHB, 2012). It is the second largest employment generator and provides jobs to approximately 33 million people (NHB, 2012). Rising incomes, favorable demographics, urbanization and inflows of foreign investments has led to an increase in the demand for housing which has not been met with supply. On average, property values have quadrupled in the last decade with rising property prices in urban areas and the housing shortage is estimated at approximately 19 million households (Srivastava, 2013; KPMG, 2012).

Over the past decade there has been a widespread expectation of rising property prices and speculation of a housing bubble in large metropolitan cities. It had been common for middle class buyers to buy houses with the intent of selling them a few years later for a 15 -20 percent gain. In metropolitan cities like Mumbai and Delhi, houses that are in the process of being constructed were sold for less than what the builder would sell them for, to buyers who plan on re-selling them in the near future. Yet, according to the Ministry of Housing and Urban Poverty Alleviation approximately 11.09 million homes in urban areas remain empty (KPMG, 2012). Sellers have been holding out in hope that property prices will continue to appreciate. As a result, houses have become increasingly unaffordable for the middle class buyer.

The recent downturn in the Indian economy has led to an overall slump in the housing market. The House Price Index (HPI) has been on a downward trend in 22 out of the 26 cities monitored by the National Housing Bank (NHB, 2013). Investor-driven real estate markets such as certain areas in Delhi and Mumbai have seen more than 10 percent fall in prices due to a slowing liquidity, a lack of buyers and a decline of investor confidence in

the property market (Chadha, 2013). Against the backdrop of falling prices, the question about a housing bubble and a potential housing bust has become increasingly pertinent.

## IV. Dynamics of the Housing Market

Two industries closely linked to the housing market in India are the housing finance industry and the construction industry. The market for home loans is expected to grow at a ~17 percent CAGR over the next five years due to increase in the number of transactions, a higher loan to value (LTV) ratio and increasing property prices (Rupee Manager, 2013). The two major players that operate within this space are Housing Finance Companies (HFCs) and Scheduled Commercial Banks (SCBs). While HFCs are regulated by the National Housing Bank (NHB), SCBs are regulated by the Reserve Bank of India. While SCBs dominated the market in the late 1990s due to the prevalence of low interest rates, rising incomes and stable property prices, the current market share is split almost equally between the two (Rupee Manager, 2013). The main difference between these institutions is their source of funds, with banks depending on their own equity reserves and HFCs depending on loans from banks, financing from the NHB, fixed deposits from the public and borrowing through bonds and debentures in addition to their own equity reserves (Rupee Manager, 2013). In recent years, the availability of affordable home loans at low interest rates has been increasing. The Indian government has played a role in this, by offering tax concessions to boost demand for housing. As a result, the penetration of housing finance has reached an estimated 38 percent in urban areas (Prem, 2012).

In spite of the recent growth in demand for housing, there are several constraints to real estate development. Firstly, there is a shortage of land in urban areas with growing population densities as a result of urbanization. The shortage of land is exacerbated by the existence of the Urban Land Ceiling Act passed in 1976 that restricts the land available for construction and development (KPMG, 2012). In 2007, the state of

Maharashtra repealed this Act, releasing close to 3,000 acres for development in Mumbai (CNN IBN, 2007). Nevertheless, inefficient land use by the public sector continues to limit its availability.

Secondly, cumbersome regulation lengthens the process and increases the cost of housing development. Estimates suggest that real estate developers need to pass approvals through 150 tables in 40 government departments. Delays in approvals add 25-30 percent to project costs and it currently takes two to three years for a developer to begin construction after purchasing land (KPMG, 2012).Lastly, rising construction costs further impede the development of real estate. While land forms the largest component of premium residential real-estate projects, construction costs are 50 to 60 percent of the selling price for affordable housing (KPMG, 2012).

## VI. Data

My approach is modeled after a research paper published by the Reserve Bank of India (Joshi, 2006). In order to investigate the existence of a housing price bubble, Joshi employs a structural VAR model proposed by Blanchard and Quah (1989) to study the impact of monetary variables and income growth on the housing price shocks in India. My objective is to test the extent to which the macroeconomic fundamentals support the growth rate of national level house prices. I build on Joshi (2006) to test the hypothesis that there is a city-fixed effect that impacts the relationship between the macroeconomic fundamentals and the growth in house prices. Additionally, I use Joshi (2006) to inform the use of appropriate proxies for residential real-estate market data that is not available on a quarterly basis. I construct a panel of fifteen tier-I and tier-II cities over 15 quarters since 2009 using time series data published by the Reserve Bank of India.

Dependent Variable

In order to assess whether house price growth is supported by the macroeconomic fundamentals, I use the quarterly growth in house prices for each city as my dependent variable: *hg*. This growth rate is based on an Index constructed by the National Housing Bank (NHB) called the *Residex* or the House Price Index (HPI). The *Residex* is calculated using primary data on house prices from real-estate agents and housing finance companies using a weighted average method. The quarterly growth rate is calculated as:

$$hg_{it} = log(HPI_{it}) - \log(HPI_{it-1}) \quad \textbf{(1)}$$

Independent Variables

My dependent variables include measures and proxies of macroeconomic fundamentals expected to impact growth in house prices.

*real_ir* represents the quarterly real interest rates. Modeled after the RBI report, the weighted-average call money rate is used as a proxy for the interest rate on home loans because housing finance companies and scheduled commercial banks change their rates in sync with the short term money market rates. *infl_rate* represents the quarterly levels of Consumer Price Index to reflect changes in overall price inflation. This interest rate is adjusted for the change in inflation during each quarter, and therefore represents the real interest rate:

$$real\_ir_t = IntRate_t - infl\_rate_{t-1} \quad \textbf{(2)}$$

*creditg* is a proxy for quarterly growth in credit deployment to the housing sector. It is a measure of non-food credit deployment, of which housing credit forms a large proportion (Joshi, 2006) and is calculated as follows:

$$creditg_t = log(Credit_t) - \log(Credit_{t-1}) \quad \textbf{(3)}$$

*gdpg* represents the quarterly growth in India's Gross Domestic Product and is used as a proxy for overall growth in demand. However, given that the housing sector forms a significant proportion of GDP, it is difficult to determine whether GDP growth is

representative of changes in overall demand or reflective of growth in construction in the real-estate sector.

$$gdpg_t = log(GDP_t) - \log(GDP_{t-1}) \quad \textbf{(4)}$$

The following table displays the summary statistics for each variable:

| Variable | Obs | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| hg | 210 | 2.67% | 7.67% | -16.80% | 31.11% |
| real_ir | 210 | 4.67% | 1.86% | 1.47% | 8.26% |
| gdpg | 210 | 2.34% | 5.46% | -6.85% | 9.71% |
| creditg | 210 | 4.27% | 1.68% | 0.81% | 7.17% |
| infl_rate | 210 | 2.23% | 5.04% | 0% | 4.15% |

Limitations

Several constraints limited the number and types of variables I chose to include. Firstly, my variables reflect changes in macroeconomic fundamentals rather than city-level economic fundamentals due to the unavailability of city-level data. A more appropriate test for the existence of a bubble would measure the deviation of house prices from economic demand and supply within the city. Given that different cities in my sample are in different stages of economic development, they have different levels of income, financial penetration and residential construction. Secondly, the model could be improved by including a variable related to housing construction as a proxy for the supply side of the residential real-estate industry.

Thirdly, the data captures only part of the time period during which there has been speculation about a housing bubble. A more appropriate model would include data extending to the early 2000s when property prices in big metropolitan cities first began to soar[2].

Lastly, although the goal of this thesis is to investigate the housing bubble hypothesis by testing for deviation from macroeconomic fundamentals, the Case-Shiller method of comparing growth in house prices with growth in rental yields could provide more conclusive results about the existence of a property bubble. One of the major qualitative motivations for my hypothesis is that Indian home-buyers are often more concerned with purchasing houses as investments than rental gains. A model investigating the extent to which growth in home prices can be explained by growth in rental yields, reflecting demand for living space could provide valuable insights into the existence of a bubble.

[2] Figure 2

## VII. Methodology

My starting point to investigate the relationship between macroeconomic fundamentals and growth in house prices across different cities is a fixed effects model assuming heteroscedasticity-robust standard errors[3]:

$$hg_{it} = \beta_1 real\_ir_{it} + \beta_2 infl\_rate_{it} + \beta_3 gdpg_{it} + \beta_4 creditg_{it} + \alpha_i + u_{it}$$

$\alpha_i$: the unknown intercept for each entity (i=1…n)

$hg_{it}$: the dependent variable (i= entity and t= time)

$\beta_{1\ldots4}$ : the coefficient for the independent variables

$u_{it}$: the error term

I construct binary variables for each city and each time period in order to investigate city-fixed effects in the growth of house prices. I test the effects of grouping Delhi and Mumbai under the variable *large_city* in order to investigate whether there is a difference in the way that house prices in these markets respond to a change in macroeconomic fundamentals. Additionally, I include the independent binary variable *time1* to test for an effect on house price growth in the period of macroeconomic slowdown in FY11-12.

I modify my model based on preliminary insights into the explanatory power of my economic variables. I graph the residuals on the heteroscedasticity-robust fixed effects model in order to look for autocorrelation and consider the effects of clustering the cross-sectional residuals.

Finally, I investigate the effects of imposing structure on the residuals by using a panel-corrected standard errors (PCSE) model and a First Order Autoregressive (AR(1))

[3] the variance of the residuals is not consistent across all observation points

model to test the hypothesis that the residual $u_{it}$ is related to the residual in the previous period, $u_{it-1}$ across cities at each point in time.

## VIII. Results

**Table 1** displays the results of the heteroscedasticity-robust fixed effects regression. The coefficients can be interpreted as follows:

$$hg_{it} = 0.0802 - 0.679\, real_{ir_t} - 0.519\, infl\_rate_t - 0.212 gdpg_t$$

This model attempts to explain the variation of $hg_{it}$, the house price growth for city $i$ in time period $t$ that is explained by the real interest rate, inflation rate, and GDP growth rate since the previous quarter[4]. The growth in real interest rate, *real_ir* and the growth in GDP, *gdpg* are statistically significant at 5 percent level. The coefficient on *real_ir* suggests that a 0.679 percentage point decline in the real interest rate leads to an increase in the growth rate of house prices by 1 percentage point.

The negative coefficient on *gdpg* suggests that a 0.212 percentage point decline in GDP quarterly growth rate is associated with a 1 percentage point increase in the quarterly growth rate of house prices. This result is counter-intuitive if we consider GDP to be a proxy for demand. However, there are two plausible explanations for the result. Firstly, it might suggest that GDP growth is a closer proxy for the supply-side of residential real estate. Therefore, a decline in supply leads to an increase in house prices. Alternatively, this negative relationship can be representative of a deviation of house prices from the macroeconomic fundamentals if the growth of house prices is unrelated to aggregate demand within the country. The negative coefficient on *infl_rate* reinforces the latter explanation by suggesting that growth in house prices is not positively correlated with overall inflation. The adjusted $R^2$ of this model is 0.023, indicating that only 2.3 percent of the variation in $hg_{it}$ is explained by the model.

[4] $gdpg_t = log(GDP_t) - \log(GDP_{t-1})$

**Table 2** displays the results of including a binary variable which takes a value of 1 in the period before the economic slowdown of 2010-11 (*period1)* in the original regression. *period1* is statistically significant at the 1 percent level and *gdpg* at the 5 percent level according to this model.

$$hg_{it} = -0.0307 + 0.545\, real_{ir_t} + 0.647\, infl\_rate_t - 0.233 gdpg_t + 0.535\, period1$$

The positive coefficient on *period1* suggests that quarterly growth in house prices was higher in the period before 2011-12. *gdpg* is again found to be statistically significant negatively correlated with house price growth. The adjusted $R^2$ indicates that this model explains 6 percent of variation in $hg_{it}$. In other words, the macroeconomic variables included in this model account only for 6 percent of the quarterly growth in house prices.

**Table 3** displays the results of including a time trend along with the economic variables. While including *period* along with the variables in the previous regression did not generate statistically significant results, including the time trend with the macroeconomic variables previously found to be significant generates a small, negative coefficient of 0.00235 that is significant at the 10 percent level. Several variables were developed to draw out conclusive results on the effect of large metropolitan cities, including *Delhi*, *Mumbai*, *large_city* (Delhi and Mumbai). The results in **Table 4** indicate that none of the city variables are statistically significant.

The low explanatory power and varying levels of statistical significance on the coefficients suggest that these models do not yield clear robust interpretable insights into

the impacts of macroeconomic variables. Therefore, I adopt a different approach and control for all macroeconomic movements using time period binary variables.

**Table 5** displays the results of including binary variables to test for city-fixed effects and time-fixed effects with hetereoscedasticity-robust standard errors. Although none of the coefficients on city-fixed effects are statistically significant, point estimates suggest that house price growth varies across the country with Bengaluru, Chennai, Delhi, Mumbai, Lucknow and Pune displaying higher point estimates. It is noteworthy that this includes four out of the six metropolitan cities in India. Several time periods emerge as statistically significant, indicating that period binary variables were appropriate in order to control for macroeconomic fluctuations. Additionally, the significance of period-fixed effects can be reconciled with the insight that the macroeconomic slowdown in FY2011-2012 had an effect on the residential real estate market.

Next, I turn my attention towards the residuals in order to investigate alternative models that could be appropriate. **Figure 1** depicts the residuals of the time and entity-fixed effects regression assuming heteroscedasticity-robust standard errors. The graph suggests that the residuals are not random and correlated with adjacent observations. I therefore test other models with auto-correlated standard errors.

**Table 6** displays the results of a clustering the standard errors on each city assuming that they are heteroscedastic and auto-correlated. Although point estimates of some cities (Delhi, Mumbai, Bengaluru, Chennai, Lucknow and Pune) are still higher than the rest, the standard error on all entity fixed effects are now substantially lower,

making the coefficients significant at the 0.1 percent level. The implausibly low standard error terms on each city, however, motivate me to test other models with auto-correlated standard errors that impose more structure.

**Table 7** displays the results of the city-fixed effects generated by three different models used to impose structure on the standard errors. Model (1) imposes a common AR1 autocorrelation structure assuming panel-level heteroscedastic errors (no cross-sectional correlation). Model (2) imposes a panel-specific AR1 autocorrelation structure and Model (3) imposes a panel-specific AR1 autocorrelation structure with panel-level heteroscedastic errors. All three models suggest that Hyderabad has a negative coefficient, statistically significant at the 10 percent level. This suggests that house price growth has been below-normal in Hyderabad. Model (2), imposing AR1 autocorrelation assuming no cross-sectional correlation, suggests that house prices in Kolkata display below-normal growth (statistically significant at the 1 percent level). These models display $R^2$s of 0.295, 0.325 and 0.325 respectively, suggesting that the first model explains ~30 percent of the variation in $hg_{it}$, and the models imposing panel-specific AR1 autocorrelation structure explain ~33 percent.

## IX. Conclusion

According to the available data, different models suggest that different conclusions can be drawn about the statistical significance of macroeconomic factors affecting the growth in house prices across India. Contrary to the literature, and speculation about property bubbles in large metropolitan cities, my results do not provide conclusive evidence for above-normal growth rates. One major qualification of the data, however, is that it begins in 2009. **Figure 2** shows trends in house prices during 2001-2013 and Figure 3 shows house price growth in Delhi and Mumbai during the same period. The graphs suggest that Delhi and Mumbai both display above-normal house price levels, and rapid growth rates between 2005-2007 and 2011-12. Rapid increases in growth rates during some periods justify the intuition guiding speculation about a house price bubble. However, the evidence presented in this paper reinforces evidence presented by Joshi (2006), suggesting that the increases in prices are not enough to draw conclusive evidence about the existence of a bubble.

My findings suggest that a shift in the overall macroeconomic environment during FY11-12, however, had an impact on overall growth in house prices. Due to shifts in demographics and urbanization, residential-real estate markets are continuously evolving across different cities within the country. A more appropriate test to evaluate the city-specific effects of different housing markets would include population data to account for shifts in population, construction data to account for the varying levels of real-estate development across the country, and credit-penetration data to account for the differences in access to housing finance across different cities. Although the findings of this thesis are inconclusive about the existence of an asset bubble in the residential real-estate

market, it is imperative that future research builds on city-level models in order to investigate the trends in house prices.

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## XI. Appendix

**Table 1: xtreg real_ir infl_rate gdpg, fe vce(robust)**

| | hg |
|---|---|
| **real_ir** | **-0.679*** |
| | (0.305) |
| **infl_rate** | -0.519 |
| | (0.310) |
| **gdpg** | **-0.212*** |
| | (0.0739) |
| **_cons** | 0.0802** |
| | (0.0244) |
| **N** | **210** |
| **adj. R-sq** | **0.023** |

Standard errors in parentheses
+ p<0.10 *p<0.05, **p<0.01, ***p<0.001

**Table 2: xtreg hg real_ir infl_rate gdpg period1, fe vce(robust)**

| | hg |
|---|---|
| **real_ir** | 0.545 |
| | (0.478) |
| **infl_rate** | 0.647 |
| | (0.738) |
| **gdpg** | **-0.233*** |
| | (0.0923) |
| **period1** | **0.0535**** |
| | (0.0171) |
| **_cons** | -0.0307 |
| | (0.0431) |
| **N** | **210** |
| **adj. R-sq** | **0.060** |

Standard errors in parentheses
+ p<0.10 *p<0.05, **p<0.01, ***p<0.001

**Table 3: (1) xtreg hg real_ir infl_rate gdpg period, fe vce(robust)**

**(2) xtreg hg real_ir gdpg period, fe vce(robust)**

| | (1) | (2) |
|---|---|---|
| | hg | hg |
| **real_ir** | -0.374 | -0.181 |
| | (0.427) | (0.313) |
| **infl_rate** | -0.367 | |
| | (0.654) | |
| **gdpg** | **-0.195+** | **-0.168*** |
| | (0.0955) | (0.067) |
| **period** | -0.00159 | **-0.00235+** |
| | (0.00141) | (0.0013) |
| **_cons** | 0.0704* | 0.0591*** |
| | (0.0267) | (0.0133) |
| N | 210 | 210 |
| adj. R-sq | 0.021 | 0.025 |

Standard errors in parentheses
+ p<0.10 *p<0.05, **p<0.01, ***p<0.001

**Table 4: (1) reg hg large_city real_ir gdpg period, robust**

**(2) reg hg Delhi real_ir gdpg period, robust**

**(3) reg hg Mumbai real_ir gdpg period, robust**

| | (1)<br>hg | (2)<br>hg | (3)<br>hg |
|---|---|---|---|
| **large_city** | 0.0182 | | |
| | (0.0119) | | |
| **real_ir** | -0.181 | -0.181 | -0.181 |
| | (0.327) | (0.328) | -0.329 |
| **gdpg** | **-0.168+** | **-0.168+** | **-0.168+** |
| | (0.0957) | (0.096) | (0.0959) |
| **period** | **-0.00235+** | **-0.00235+** | **-0.00235+** |
| | (0.00132) | -0.00132 | (0.00132) |
| **Delhi** | | 0.0147 | |
| | | (0.0145) | |
| **Mumbai** | | | 0.0144 |
| | | | (0.0129) |
| **_cons** | 0.0555*** | 0.0581*** | 0.0581*** |
| | (0.0162) | (0.0162) | (0.0161) |
| **N** | **210** | **210** | **210** |
| **R-sq** | **0.027** | **0.02** | **0.02** |

Standard errors in parentheses
+ p<0.10 *p<0.05, **p<0.01, ***p<0.001

**Table 5: reg hg i.city i.period, vce(robust)**

| | hg | | hg |
|---|---|---|---|
| **Ahmedabad** | 0 | **2009-Q4** | 0 |
| | (.) | | (.) |
| **Bengaluru** | 0.0165 | **2010-Q1** | 0.0146 |
| | (0.0276) | | (0.0206) |
| **Bhopal** | -0.00260 | **2010-Q2** | 0.0838*** |
| | (0.0238) | | (0.0239) |
| **Chennai** | 0.0269 | **2010-Q3** | 0.0955*** |
| | (0.0213) | | (0.0173) |
| **Delhi** | 0.0137 | **2010-Q4** | 0.0818*** |
| | (0.0181) | | (0.0218) |
| **Faridabad** | -0.00301 | **2011-Q1** | -0.00758 |
| | (0.0252) | | (0.0157) |
| **Hyderabad** | -0.0241 | **2011-Q2** | 0.107** |
| | (0.0191) | | (0.0320) |
| **Jaipur** | 0.0131 | **2011-Q3** | 0.00705 |
| | (0.0340) | | (0.0154) |
| **Kochi** | -0.0242 | **2011-Q4** | 0.0391* |
| | (0.0286) | | (0.0172) |
| **Kolkata** | -0.0252 | **2012-Q1** | 0.0113 |
| | (0.0221) | | (0.0218) |
| **Lucknow** | 0.00559 | **2012-Q2** | 0.0489*** |
| | (0.0202) | | (0.0108) |
| **Mumbai** | 0.0134 | **2012-Q3** | 0.0283* |
| | (0.0197) | | (0.0119) |
| **Patna** | -0.0116 | **2012-Q4** | 0.0751*** |
| | (0.0222) | | (0.0144) |
| **Pune** | 0.0181 | **2013-Q1** | 0.0395* |
| | (0.0221) | | (0.0194) |
| **Surat** | -0.0164 | **2013-Q2** | 0 |
| | (0.0265) | | (0) |
| | | **_cons** | -0.0179 |
| | | | (0.0154) |
| **N** | | | **210** |
| **R-sq** | | | **0.169** |

Standard errors in parentheses

+ p<0.10 *p<0.05, **p<0.01, ***p<0.001

**Table 6: reg hg i.city i.period, vce(cluster city)**

| | hg | | hg |
|---|---|---|---|
| **Ahmedabad** | 0 | **2010-Q1** | 0 |
| | (.) | | (.) |
| **Bengaluru** | 0.0165*** | **2010-Q2** | 0.0692+ |
| | (3.25E-17) | | (0.0384) |
| **Bhopal** | -0.00260*** | **2010-Q3** | 0.0809** |
| | (3.20E-17) | | (0.0229) |
| **Chennai** | 0.0269*** | **2010-Q4** | 0.0672+ |
| | (3.49E-17) | | (0.033) |
| **Delhi** | 0.0137*** | **2011-Q1** | -0.0222 |
| | (3.22E-17) | | (0.0285) |
| **Faridabad** | -0.00301*** | **2011-Q2** | 0.0920* |
| | (3.19E-17) | | (0.0388) |
| **Hyderabad** | -0.0241*** | **2011-Q3** | -0.00754 |
| | (3.19E-17) | | (0.0211) |
| **Jaipur** | 0.0131*** | **2011-Q4** | 0.0245 |
| | (3.23E-17) | | (0.028) |
| **Kochi** | -0.0242*** | **2012-Q1** | -0.00327 |
| | (3.22E-17) | | (0.0295) |
| **Kolkata** | -0.0252*** | **2012-Q2** | 0.0343 |
| | (3.21E-17) | | (0.0236) |
| **Lucknow** | 0.00559*** | **2012-Q3** | 0.0138 |
| | (3.32E-17) | | (0.0253) |
| **Mumbai** | 0.0134*** | **2012-Q4** | 0.0605+ |
| | (3.38E-17) | | (0.0302) |
| **Patna** | -0.0116*** | **2013-Q1** | 0.0249 |
| | (3.19E-17) | | (0.0248) |
| **Pune** | 0.0181*** | **2013-Q2** | -0.0146 |
| | (3.20E-17) | | (0.0239) |
| **Surat** | -0.0164*** | **_cons** | -0.00329 |
| | (3.22E-17) | | (0.0206) |
| **N** | | | **210** |
| **R-sq** | | | **0.276** |

Standard errors in parentheses

+ p<0.10 *p<0.05, **p<0.01, ***p<0.001

**Table 7: (1) xtpcse hg i.city i.period, correlation (ar1) hetonly**

**(2) xtpcse hg i.city i.period, correlation(psar1)**

**(3) xtpcse hg i.city i.period, correlation(psar1) hetonly**

| | (1) hg | (2) hg | (3) hg | | (1) hg | (2) hg | (3) hg |
|---|---|---|---|---|---|---|---|
| **Ahmedabad** | 0 | 0 | 0 | **Kochi** | -0.0258 | -0.0260 | -0.0260 |
| | (.) | (.) | (.) | | (0.0226) | (0.0274) | (0.0268) |
| **Bengaluru** | 0.0139 | 0.0136 | 0.0136 | **Kolkata** | -0.0258 | **-0.0259**** | -0.0259 |
| | (0.0202) | (0.0155) | (0.0188) | | (0.0166) | (0.0082) | (0.0170) |
| **Bhopal** | -0.0042 | -0.0042 | -0.0042 | **Lucknow** | 0.0042 | 0.0045 | 0.0045 |
| | (0.0180) | (0.0215) | (0.0185) | | (0.0149) | (0.0094) | (0.0140) |
| **Chennai** | 0.0241 | 0.0278 | 0.0278 | **Mumbai** | 0.0110 | 0.0110 | 0.0110 |
| | (0.0169) | (0.0272) | (0.0217) | | (0.0148) | (0.0153) | (0.0148) |
| **Delhi** | 0.0131 | 0.0039 | 0.0039 | **Patna** | -0.0144 | -0.0156 | -0.0156 |
| | (0.0144) | (0.0150) | -0.0207 | | (0.0157) | (0.0131) | (0.0130) |
| **Faridabad** | -0.0056 | -0.0060 | -0.0060 | **Pune** | 0.0159 | 0.0157 | 0.0157 |
| | (0.0185) | (0.0218) | (0.0175) | | (0.0163) | (0.0176) | (0.0158) |
| **Hyderabad** | **-0.0262+** | **-0.0263+** | **-0.0263+** | **Surat** | -0.0175 | -0.0165 | -0.0165 |
| | (0.0141) | (0.0153) | (0.0135) | | (0.0184) | (0.0144) | (0.0144) |
| **Jaipur** | 0.0110 | 0.0110 | 0.0110 | **_cons** | -0.0015 | 0.0030 | 0.0030 |
| | (0.0254) | (0.0259) | (0.0243) | | (0.0196) | (0.0118) | (0.0190) |
| **N** | | | | | **210** | **210** | **210** |
| **R-sq** | | | | | **0.295** | **0.325** | **0.325** |

Standard errors in parentheses

+ p<0.10 *p<0.05, **p<0.01, ***p<0.001

**Figure 1: Residuals of reg hg i.city i.period, vce(robust)**

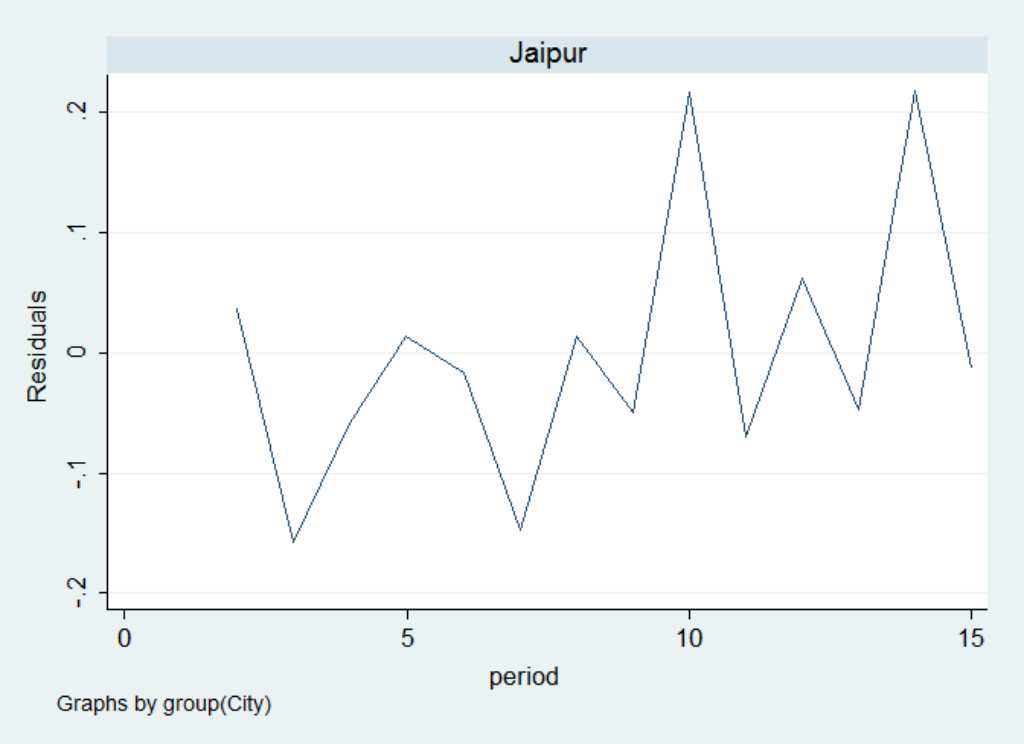


**Figure 2: House Prices (2001-2013)**

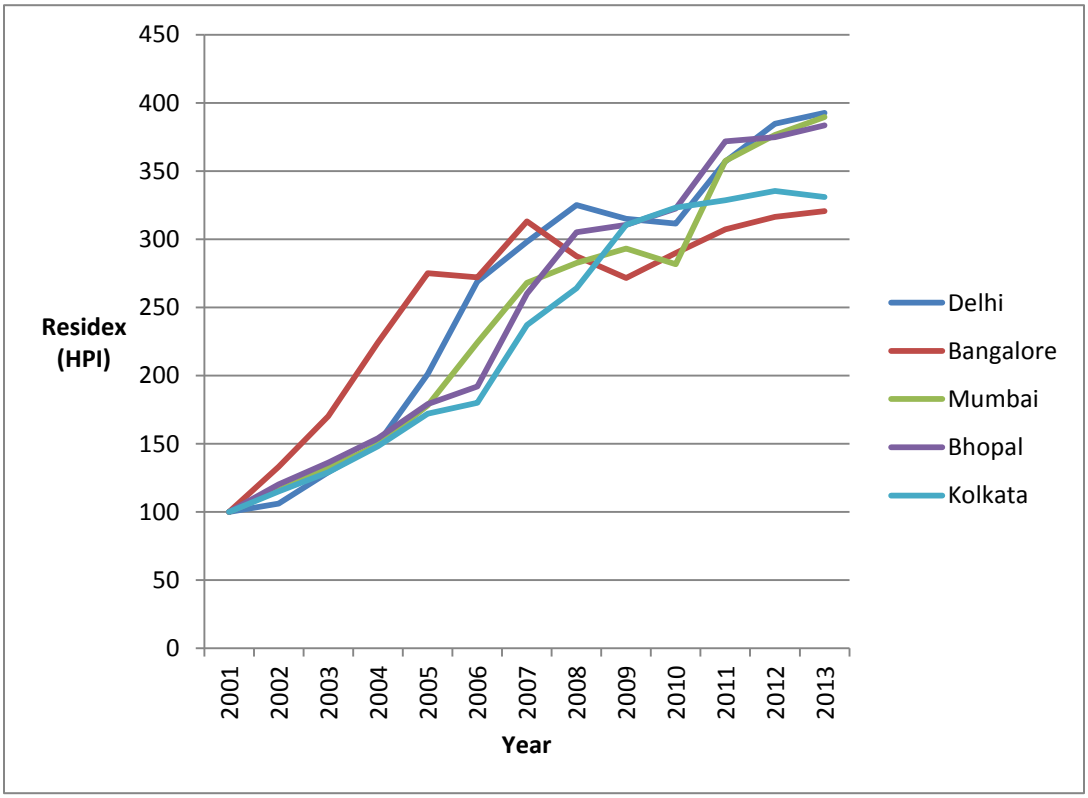

**Figure 3: House Price Growth (2001-2013)**